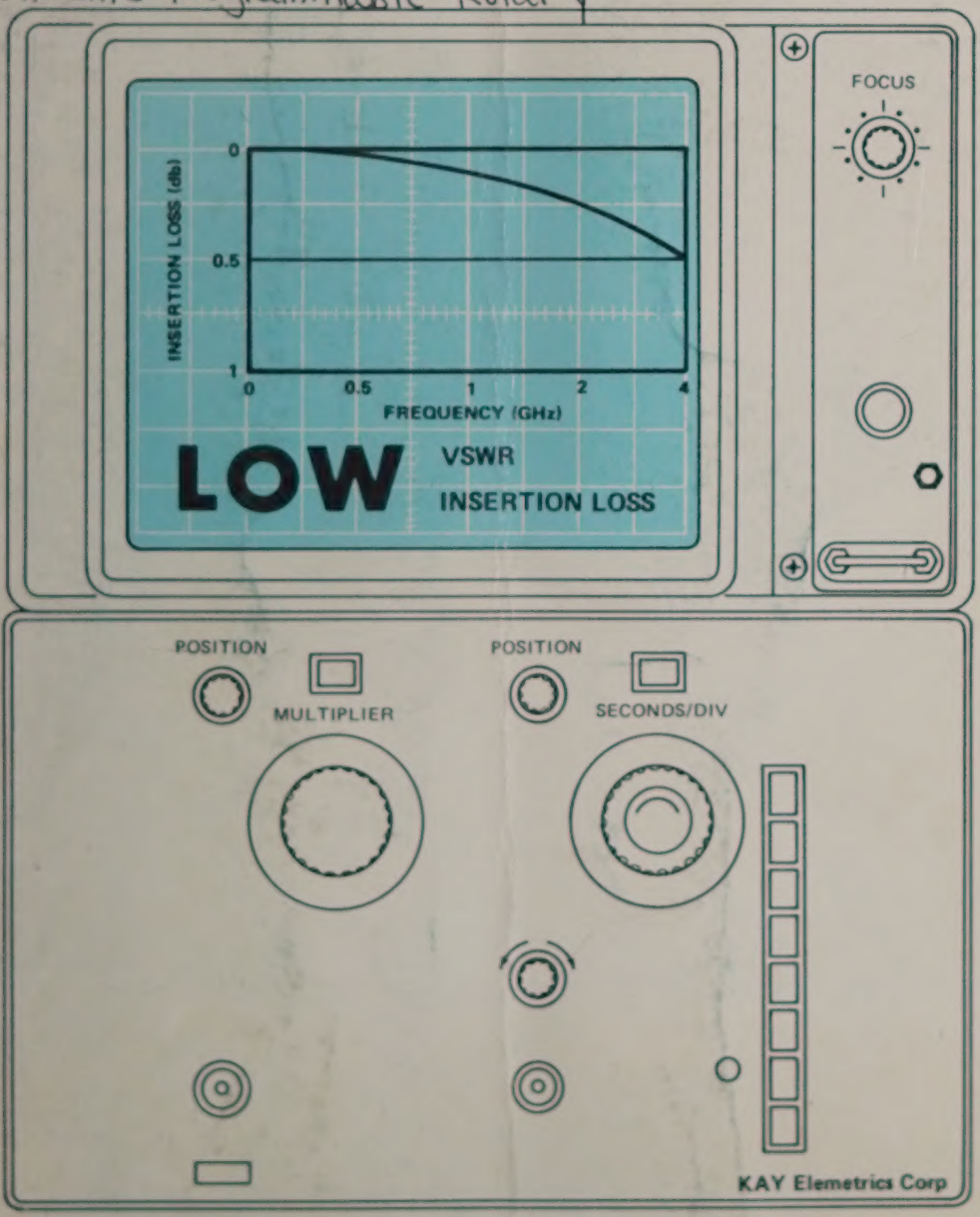
KAY ATTENUATORS

In-Line Programmable Rotary



INSTRUCTION MANUAL

ATTENUATORS

IN-LINE

PROGRAMMABLE

ROTARY

ISSUE D

APRIL 1983

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KAY ATTENUATOR MANUAL

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SECTION I

GENERAL INFORMATION

1. WARRANTY

All Kay Attenuators are warranted to be free from defects in material and workmanship. Our responsibility is limited to repairing or replacing any instrument, or part thereof, for a period of one year. This warranty shall not apply to defects resulting from improper operation or maintenance, or unauthorized modifications.

2. INCOMING INSPECTION (MECHANICAL ONLY)

After unpacking the attenuator a visual check should be made to determine if any damage was incurred during shipment. Most components are protected by the heavy housings. Items susceptible to damage are the coaxial connectors and the toggle switches.

SECTION II

SPECIFICATIONS

1. DESCRIPTION

An attenuator is a device designed to reduce power in an electrical system by introducing an accurate known loss. In Kay attenuators this loss is produced by switching in, either manually or remotely, loss networks designed for accurate wide band operation. This power loss, measured in decibels (dB), is the logarithmic ratio of the input to the output power of the attenuator. These attenuators have met rigid environmental tests and their accuracy is traceable to the National Bureau of Standards. Certificates of compliance and test data sheets are available on request. Calibration data is available for a minimal charge for each frequency at which data is required. Attenuators have many uses, including serving as accurate standards in the measurement of gain or loss and in extending the sensitivity ranges of measurement instruments, receivers and amplifiers. Attenuators are also effective for providing isolation or buffering between circuits and reducing the effects of mismatched impedances.

KAY ATTENUATOR MODELS include toggle switch inline, rotary, microwave-sliding co-axial, programmable and continuously variable types.

KAY TOGGLE SWITCH INLINE MODELS , standard and miniature sizes, are constructed with unique teflon body switches mounted in silver plated cast housings. The switches are designed for outstanding high frequency characteristics allowing use to over 1 GHz and use precious metal contacts for a long and dependable life of over 100,000 switch cycles. Inline type attenuators offer the advantage of convenient step selection flexibility and low cost.

KAY ROTARY MODELS incorporate glass epoxy impregnated switching boards with gold contacts for long reliable life with high repeatability. The rotors are made of silver plated brass with woven wire RF gaskets for precision operation to 2 GHz. Rotary type attenuators offer extended frequency characteristics and require minimum panel space.

KAY PROGRAMMABLE ATTENUATOR models offer remotely switched fixed step and continuously variable types, featuring the same high quality characteristics as is found in our inline and rotary models.

Kay also specializes in models built to customer requirements, and also offers options including panel and cabinet mounted configurations and various connector types and locations.

The factory sales and engineering departments are available to aid in solving any attenuator problems.

Phone No. (201) 227-2000

2. ELECTRICAL SPECIFICATIONS

The quality of an attenuator can be judged by studying its electrical specifications. A brief definition of the specifications of Kay attenuators is given below, followed by a table listing the specifications of the various models covered by this manual.

FREQUENCY RANGE - The frequency spectrum over which the attenuator will provide accurate measurements. Kay attenuators are designed for wide band operation.

ATTENUATION RANGE - The magnitude of the total attenuation, expressed in decibels, that the attenuator is able to provide. Some Kay models offer as high as 135 dB attenuation.

ATTENUATION STEPS - The value of the smallest switchable increment measured in dB. Example - 0 to 10 dB in 1 dB steps indicates that the attenuation range is 0 through 10 dB in 1 dB increments or steps. Several models offer increments as small as 0.1 dB.

ATTENUATION ACCURACY- The degree of precision of loss is usually specified for specific frequency ranges. It may be stated for individual steps or for total attenuation (all of the steps inserted). Accuracy may be specified in decibels or as a percentage of the attenuation value. Inline attenuator accuracy is usually specified with maximum attenuation inserted. Typical per step accuracies for Kay inline models are noted in the table below.

TYPICAL PER STEP ACCURACY

STEP VALUES	FREQUENCY RANGE		
	DC-250 MHz	250-500 MHz	500-1,000 MHz
0.1 - .9 dB	±.007 dB	±0.05 dB	±0.2 dB
1.0 - 10 dB	±0.1 dB	±0.3 dB	±0.5 dB
20 and 30 dB	±1%	±1.5%	±2%

IMPEDANCE - The impedance of an attenuator is a measure of its input and output match to a given transmission line. The nominal im-

pedance is specified and the degree to which it meets this impedance is indicated by its VSWR specifications. Kay attenuators are available in characteristic impedances of 50, 75, 90 and 600 ohms.

VSWR (RETURN LOSS) - The Voltage Standing Wave Ratio is the measure of the reflected signal at the attenuator connectors due to an impedance variance from the specified value. It may be stated as a ratio (VSWR) or in dB (Return Loss). Poor VSWR characteristics result in inferior attenuation accuracies and also add to the insertion loss. Kay attenuators are designed and tested for low VSWR ratios (high return loss) over their entire frequency ranges. See conversion chart for VSWR to return loss relationships, page 28.

INSERTION LOSS - This is the loss of power resulting from inserting an attenuator set to "0" dB or minimum attenuation into a system. Insertion loss must be kept as low and constant as possible over the entire frequency range to assure accurate measurements. The effect of insertion loss is to add additional loss to the nominal attenuation. Kay attenuators are specifically designed to provide low insertion losses through the use of low loss materials and careful individual tuning.

POWER - The maximum input power (watts) that may be applied to the attenuator which will not affect its specifications.

Kay step attenuators are rated for operating temperatures of -55 to +85°C and storage temperatures of -55 to +125°C.

INLINE 50 OHMS

		STANDARD				MINIATURE				
MODEL		430	431	432	1/432	437	438	439	1/439	460
FREQ RANGE(MHZ)		DC-1000	DC-1000	DC-1000	DC-500	DC-1000	DC-1000	DC-1500	DC-1000	DC-1000
ATT. RANGE (dB)		10-51	0-41	0-101	0-22.1	0-102.5	0-41	0-101	0-22.1	0-132
STEP(dB)		1	1	1	0.1	0.5	1	1	0.1	1
ACCURACY (± dB) or % of dB (MHZ)	DC -250	0.5	0.5	0.6	0-.5 dB ±.05/ step	0.5	0.5	0.5	0-.5 dB ±.05/ step	0.5
	250 -500	0.9	0.9	1.2		1.0	1.0	1.0		1.0
	500-1000	1.2	1.2	2.0	1-10 dB ±.3/step	1.5	1.5	1.5	1-10 dB ±.3/step	1.5
	1000-1500							3		
VSWR (MHZ)	DC -250	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	250-500	1.4	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.2
	500-1000	1.4	1.4	1.4		1.4	1.4	1.4	1.4	1.4
	1000-1500							1.4		
INSERTION LOSS (dB)	DC -250	10.1	.1	.1	.1	.1	.1	.1	.1	.1
	250 -500	10.2	.2	.3	.2	.2	.2	.2	.2	.2
	500-1000	10.5	.5	.7		.5	.5	.5	.5	.5
	1000-1500							.8		
POWER (WATTS)		1	1	1	1	1	1	1	1	1
CONNECTOR		BNC	BNC	BNC	BNC	TNC	BNC	BNC	BNC	TNC
TOTAL STEPS		6 STEP	6 STEP	9 STEP	9 STEP	9 STEP	6 STEP	9 STEP	9 STEP	9 STEP
WEIGHT		2 lbs .9 Kg	3 lbs 1.36 Kg	3 lbs 1.36 Kg	3 lbs 1.36 Kg	8 oz .23 Kg	6 oz .17 Kg	8 oz .23 Kg	8 oz .23 Kg	8 oz .23 Kg

For physical dimensions, see page 9.

OPTIONS -

- 19" rack mounted, add RM to model number
- Rack mount with panel connectors, add RMA to model number
- Connector location (see outline drawing page 9), add location designation to model number
- Mounting holes (standard models only, see page 9), add KS to model number, normally supplied on miniature models
- Optional connectors - TNC, SMA, N
- Switch handle boots are available

INLINE 75 OHMS

		STANDARD			MINIATURE				
MODEL		441	442	1/442	447	448	449	1/449	470
FREQ RANGE(MHZ)		DC-1000	DC-1000	DC-500	DC-1000	DC-1000	DC-1000	DC-500	DC-1000
ATT. RANGE (dB)		0-41	0-101	0-22.1	0-102.5	0-41	0-101	0-22.1	0-132
STEP(dB)		1	1	0.1	0.5	1	1	.1	1
ACCURACY (±dB or % of dB)	DC -250	0.5	1.0	5%	1.0	0.5	1.0	0-.5 dB ±.05/ step	1.0
	250-500	0.9	1.2	5%	1.5	1.0	1.5		1.5
	500-1000 (MHZ)	1.2	2.0		2.0	1.0	2.0	1-10 dB ±.3/step	2.0
VSWR (MHZ)	DC -250	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	250-500	1.2	1.2	1.4	1.2	1.2	1.2	1.2	1.2
	500-1000	1.4	1.4		1.4	1.4	1.4		1.4
INSERTION LOSS (dB)	DC -250	.1	.1	.1	.1	.1	.1	.1	.1
	250-500	.2	.2	.2	.2	.2	.2	.2	.2
	500-1000	.4	.4		.4	.4	.4		.4
POWER (WATTS)		1	1	1	.5	.5	.5	1	.5
CONNECTOR		BNC	BNC	BNC	BNC	BNC	BNC	BNC	BNC
TOTAL STEPS		6 STEP	9 STEP	9 STEP	9 STEP	6 STEP	9 STEP	9 STEP	9 STEP
WEIGHT		2 lbs .90 Kg	3 lbs 1.36 Kg	3 lbs 1.36 Kg	8 oz .23 Kg	6 oz .17 Kg	8 oz .23 Kg	8 oz .23 Kg	8 oz .23 Kg

OPTIONS -

For physical dimensions, see page 9.

- 19" rack mounted, add RM to model number
- 19" rack mounted with panel mounted connectors, add RMA to model number

- Connector location - (see outline drawing page 9), add location designation to model location

- Mounting holes - (standard models only), add KS to model number; normally supplied with miniature models

- Optional connectors - TNC, F, N

- Switch handle boots are available

INLINE 90 OHMS

		STANDARD		
MODEL		451	452	1/452
FREQ RANGE (MHZ)		DC-500	DC-500	DC-250
ATT. RANGE (dB)		0-41	0-101	0-22.1
STEP (dB)		1	1	0.1
ACCU-RACY (± dB or % of dB)	DC -250	0.5	1.0	100 MHz ± 5 %
	250-500	1.2	2.0	
	500-1000 (MHZ)			250 MHz ± 10 %
V S W R (MHZ)	DC -250	1.3	1.3	1.4
	250-500	1.5	1.5	
	500-1000			
INSER-TION LOSS (dB)	DC -250	.1	.1	.1
	250-500	.2	.2	
	500-1000			
POWER (WATTS)		.5	.5	1
CONNECTOR		BNC	BNC	BNC
TOTAL STEPS		6 STEP	9 STEP	9 STEP
WEIGHT		2 lbs .90 Kg	3 lbs 1.36 Kg	3 lbs 1.36 Kg

For physical dimensions, see page 9.

OPTIONS -

- 19" rack mounted, add RM to model number
- 19" rack mounted with panel mounted connectors, add RMA to model number

- Connector location - (see outline drawing page 9), add location designation to model number

- Mounting holes - (standard models only), add KS to model number, normally supplied with miniature models

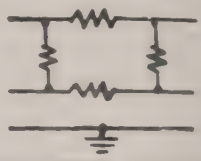
- Optional connectors - TNC, N

- Switch handle boots are available

LOW FREQUENCY R.F. AND SONIC AND ULTRASONIC MODELS

STANDARD SIZE INLINE

IDEAL FOR LOW LEVEL SIGNALS OR ELECTRICALLY NOISY ENVIRONMENTS



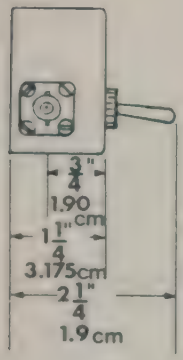
	UNBALANCED			BALANCED		
MODEL	632	665		633	666	
IMPEDANCE	50 OHMS	600 OHMS		50 OHMS	600 OHMS	
FREQ RANGE	DC-5 MHz	DC-1 MHz		DC-5 MHz	DC-20 KHz	
ATT. RANGE (dB)	0-132	0-132		0-132	0-132	
ATT. STEP (dB)	1	1		1	1	
ACCURACY OVERALL (dB)	±0.8	±0.8		±0.8	±0.3	
VSWR	1.1	1.1		1.1	1.1	
INSERTION LOSS (dB)	0.1	0.1		0.1	0.1	
POWER (WATTS)	1	1		1	1	
STD CONNECTOR	BNC	BNC		TRI-RAX (QUAD-RAX optional)	TRI-RAX (QUAD-RAX optional)	
STEP VALUES (dB)	1 2 3 6 10 20 30			30	30	
WEIGHT	3 POUNDS, (1.36 Kg)					

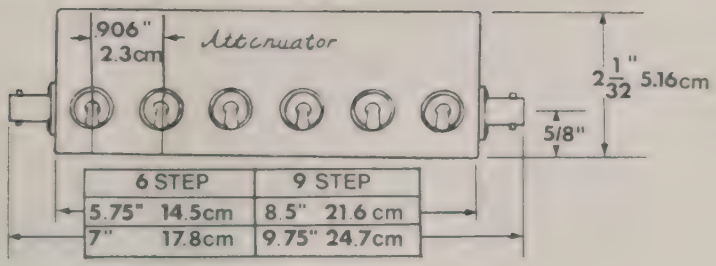
OPTIONS -

For physical dimensions, see page 14.

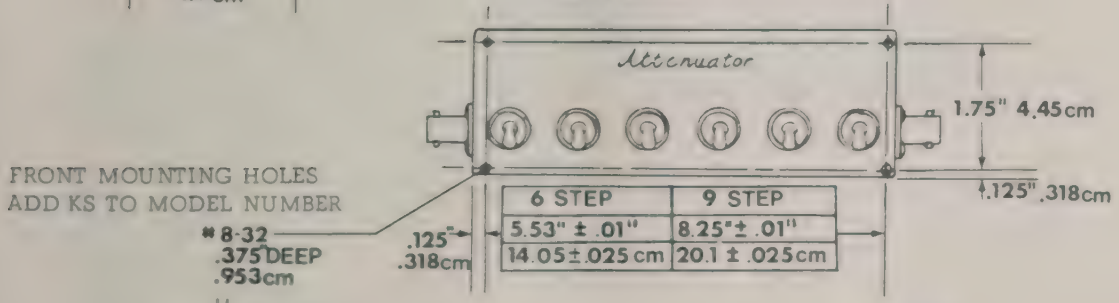
- 19" rack mounted, add RM to model number
- 19" rack mounted with panel mounted connectors, add RMA to model number
- Mounting holes, add KS to model number
- Connector location - (unbalanced only, see outline drawing), add location designation to model number
- Switch boots are available

STANDARD INLINE
6 AND 9 STEP MODELS



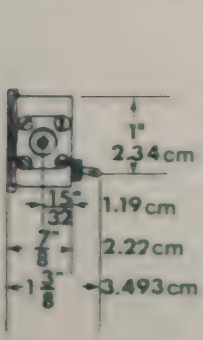


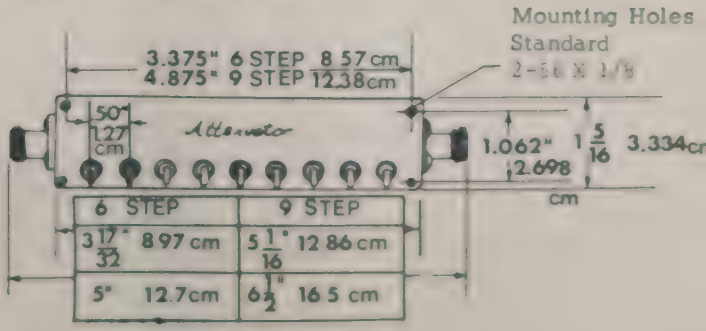
OPTIONS



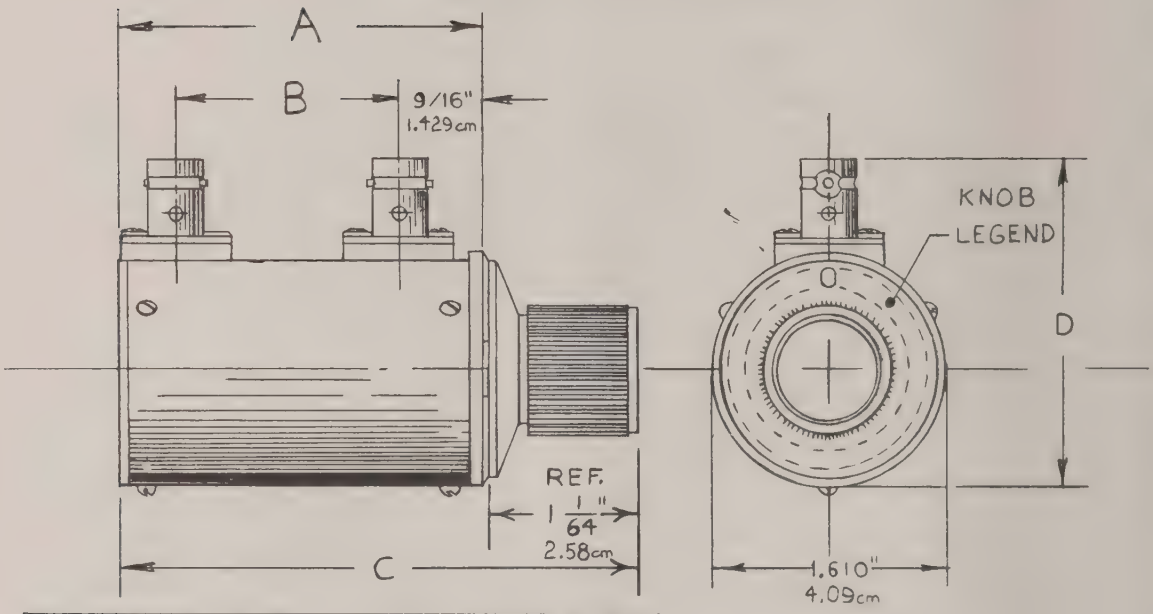
CONNECTORS AT C AND D POSITION-STANDARD
OPTIONAL POSITIONS (ANY COMBINATION) : SPECIFY ON ORDER

MINIATURE INLINE 6 AND 9 STEP

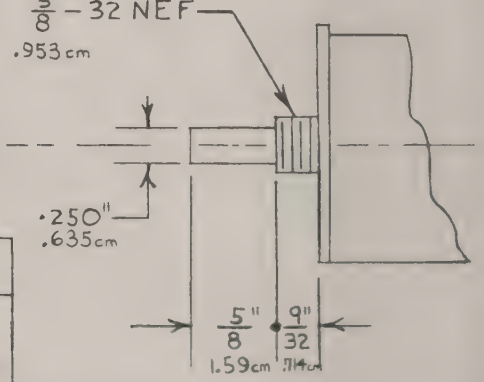




ROTARY ATTENUATOR DIMENSIONS



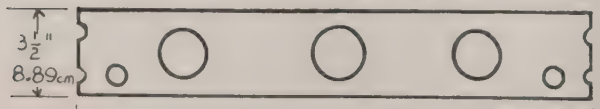
CONNECTOR TYPE	DIMENSION D
BNC, F, TNC	2 27/64 6.15cm
SMA	2 5/64 5.28cm
AMPHENOL 27-3, 27-9	2 5/64 5.48cm
AMPHENOL 27-21	2 11/64 5.52cm



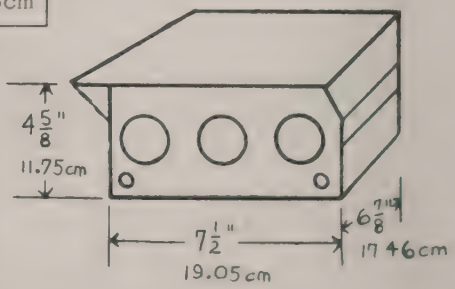
CABINET MOUNTED MODELS

MODEL	DIMENSIONS			
	A	B	C/MIN	C/MAX
500, 510 1/500, 1/510	1 45/64 4.33cm	3/4 1.91cm	2 3/4 6.99cm	3 1/2 8.89cm
520, 530	2 5/16 5.87cm	1 23/64 3.45cm	3 23/64 8.53cm	3 41/64 9.25cm

RACK MOUNTED MODELS



R.F. CONNECTORS ON FRONT PANEL
OPTIONAL ON RACK MOUNT UNITS.



ROTARY 50 OHMS

		SINGLE ROTARY			CABINET MOUNTED		RACK MOUNTED	
MODEL		1/500	500	520	5050	5150	5435	5436
FREQ RANGE (MHZ)		DC-1000	DC-2000	DC-2000	DC-1000	DC-2000	DC-1000	DC-2000
ATT. RANGE (dB)		0-1	0-10	0-70	0-81	0-80	0-81	0-80
STEP (dB)		0.1	1	10	0.1	1.0	0.1	1.0
ACCURACY (± dB or % of dB) MHZ	DC-250	.025	.1	1%+.1	1%+.2	1%+.2	1%+.2	1%+.2
	250-500	.025	.1	1%+.1	1%+3	1%+.3	1%+.3	1%+.3
	500-1000	.025+2%	.3	1%+.2	1%+.5	1%+.5	1%+.5	1%+.5
	1000-2000		.5	2%+.2		2%+.7		2%+.7
VSWR (MHZ)	DC-250	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	250-500	1.1	1.1	1.15	1.3	1.2	1.3	1.2
	500-1000	1.2	1.2	1.2	1.5	1.4	1.5	1.4
	1000-2000		1.3	1.3		1.5		1.5
INSERTION LOSS dB (max)	DC-250	0.1	0.1	0.1	.3	.2	.3	.2
	250-500	0.1	0.1	0.1	.4	.3	.4	.3
	500-1000	0.2	0.2	0.2	.8	.6	.8	.6
	1000-2000		0.3	0.3		.8		.8
POWER (WATTS)		1	1	.5	.5	.5	.5	.5
CONNECTOR		BNC	BNC	BNC	BNC	BNC	BNC	BNC
WEIGHT		7 oz .2 Kg	7 oz .2 Kg	9 oz .25 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg

Optional connectors - TNC, SMA

Rack and cabinet models will be supplied with panel mounted connectors unless otherwise specified

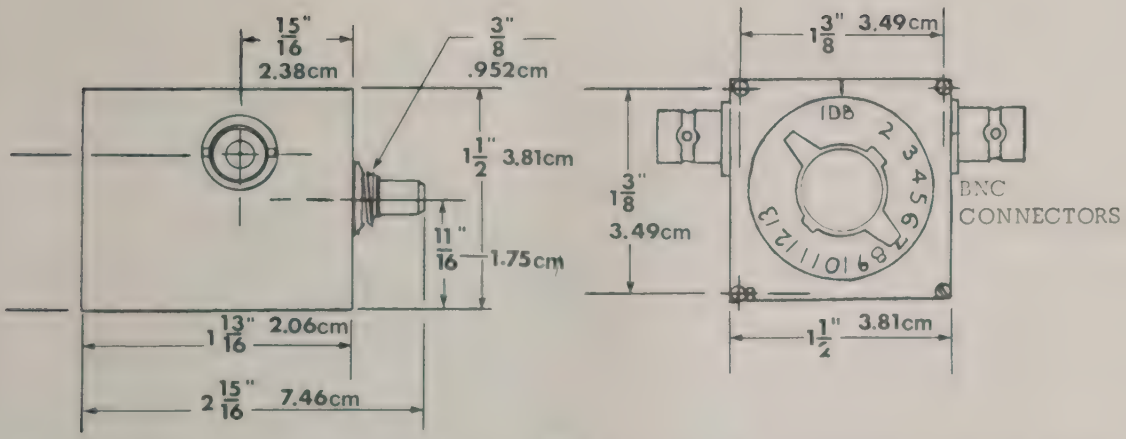
ROTARY 75 OHMS

		SINGLE ROTARY			CABINET MOUNTED		RACK MOUNTED	
MODEL		1/510	510	530	5075	5175	5445	5446
FREQ RANGE (MHZ)		DC-500	DC-1500	DC-1500	DC-500	DC-1500	DC-500	DC-1500
ATT. RANGE(dB)		0-1	0-10	0-70	0-81	0-80	0-81	0-80
STEP(dB)		0.1	1	10	0.1	1.0	0.1	1.0
ACCURACY (± dB or % of dB) (MHZ)	DC-250	.025	.1	1%+.1dB	1%+.2dB	1%+.2dB	1%+.2dB	1%+.2dB
	250-500	.025	.1	1%+.1	1%+.3	1%+.3	1%+.3	1%+.3
	500-1000		.3	1%+.2		1%+.5		1%+.5
	1000-1500		.3	2%+.2		2%+.7		2%+.7
VSWR (MHZ)	DC-250	1.1	1.1	1.1	1.3	1.3	1.3	1.3
	250-500	1.2	1.15	1.15	1.5	1.4	1.5	1.4
	500-1000		1.2	1.2		1.5		1.5
	1000-1500		1.3	1.3		1.5		1.5
INSERTION LOSS dB (max)	DC-250	.1	.1	.1	.3	.2	.3	.2
	250-500	.1	.1	.1	.5	.3	.5	.3
	500-1000		.2	.2		.5		.5
	1000-1500		.3	.3		.8		.8
POWER(WATTS)		1	1	0.5	0.5	0.5	0.5	0.5
CONNECTOR		BNC	BNC	BNC	BNC	BNC	BNC	BNC
WEIGHT		7 oz .2 Kg	7 oz .2 Kg	9 oz .25 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg

Optional connectors - TNC, F

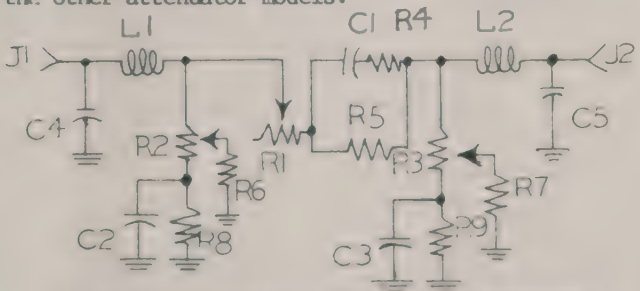
Rack and cabinet mounted models will be supplied with panel mounted connectors unless otherwise specified

CONTINUOUSLY VARIABLE
MODEL 0/400 AND 0/410



		CONT. VARIABLE	
		50 OHM	75 OHM
MODEL		0/400	0/410
FREQ RANGE		DC- 500 MHz	DC- 400 MHz
ATT. RANGE (dB)		1 - 13	2 - 14
STEP (dB)		VARIABLE	
ACCURACY (± dB or % of dB)	DC- 250	± 0.3 dB	± 0.3 dB
	250-500	± 0.3	± 0.3
VSWR	DC- 250	1.3	1.3
	250-500	1.3	1.3
INSERTION LOSS (max) dB	DC- 250	1	2
	250-500	1	2
POWER (WATTS)		1	1
CONNECTOR		BNC	BNC
WEIGHT		4 oz .11 Kg	4 oz .11 Kg

The 0/400 and 0/410 are continuously variable models. They consist of three potentiometers ganged together which form the three sections of a PI network with high frequency compensation added for wide-band operation. Use the same check-out procedures as the other attenuator models.



MODEL	0/400	0/410
R1	100 VAR LIN	200 VAR LIN
R2, R3	1K VAR dB	1K VAR dB
R4	10	15
R5	8.2	18
R6, R7	75	107
R8, R9	390	390
C1	50	24
C2	3.3	-
C3	4.7	2
C4	*	*2
C5	*.47	*3
L1, L2	-	3T, #28, 1/8 Dia

UNLESS INDICATED OTHERWISE-
ALL RESISTORS ARE IN OHMS, 1/4 WATTS
ALL CAPACITORS ARE IN PICO FARADS
* INDICATES FACTORY SELECTED

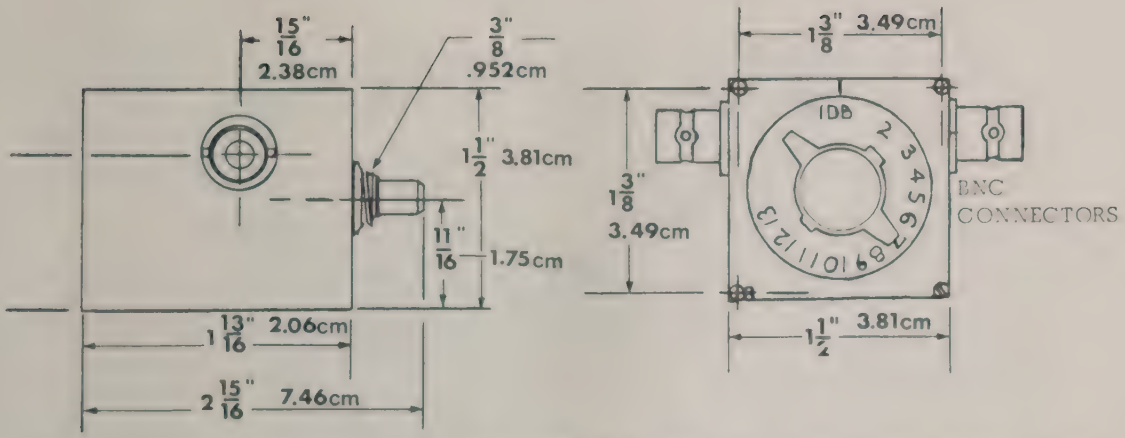
ROTARY 75 OHMS

		SINGLE ROTARY			CABINET MOUNTED		RACK MOUNTED	
MODEL		1/510	510	530	5075	5175	5445	5446
FREQ RANGE(MHZ)		DC-500	DC-1500	DC-1500	DC-500	DC-1500	DC-500	DC-1500
ATT. RANGE(dB)		0-1	0-10	0-70	0-81	0-80	0-81	0-80
STEP(dB)		0.1	1	10	0.1	1.0	0.1	1.0
ACCURACY (± dB or % of dB) (MHZ)	DC-250	.025	.1	1%+.1dB	1%+.2dB	1%+.2dB	1%+.2dB	1%+.2dB
	250-500	.025	.1	1%+.1	1%+.3	1%+.3	1%+.3	1%+.3
	500-1000		.3	1%+.2		1%+.5		1%+.5
	1000-1500		.3	2%+.2		2%+.7		2%+.7
VSWR (MHZ)	DC-250	1.1	1.1	1.1	1.3	1.3	1.3	1.3
	250-500	1.2	1.15	1.15	1.5	1.4	1.5	1.4
	500-1000		1.2	1.2		1.5		1.5
	1000-1500		1.3	1.3		1.5		1.5
INSERTION LOSS dB (max)	DC-250	.1	.1	.1	.3	.2	.3	.2
	250-500	.1	.1	.1	.5	.3	.5	.3
	500-1000		.2	.2		.5		.5
	1000-1500		.3	.3		.8		.8
POWER(WATTS)		1	1	0.5	0.5	0.5	0.5	0.5
CONNECTOR		BNC	BNC	BNC	BNC	BNC	BNC	BNC
WEIGHT		7 oz .2 Kg	7 oz .2 Kg	9 oz .25 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg	3 lbs 1.36 Kg	2.5 lbs 1.13 Kg

Optional connectors - TNC, F

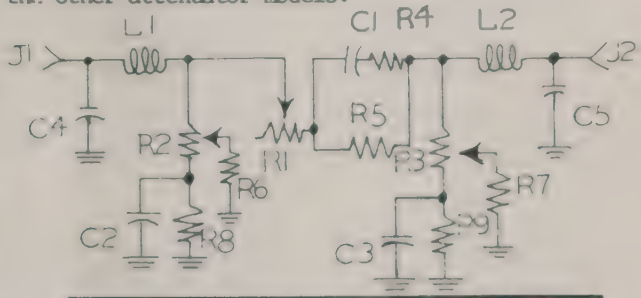
Rack and cabinet mounted models will be supplied with panel mounted connectors unless otherwise specified

CONTINUOUSLY VARIABLE
MODEL 0/400 AND 0/410



		CONT. VARIABLE	
		50 OHM	75 OHM
MODEL		0/400	0/410
FREQ RANGE		DC- 500 MHz	DC- 400 MHz
ATT. RANGE (dB)		1 - 13	2 - 14
STEP (dB)		VARIABLE	
ACCURACY (± dB or % of dB)	DC- 250	± 0.3 dB	± 0.3 dB
	250-500	± 0.3	± 0.3
VSWR	DC- 250	1.3	1.3
	250-500	1.3	1.3
INSERTION LOSS (max) dB	DC- 250	1	2
	250-500	1	2
POWER (WATTS)		1	1
CONNECTOR		BNC	BNC
WEIGHT		4 oz .11 Kg	4 oz .11 Kg

The 0/400 and 0/410 are continuously variable models. They consist of three potentiometers ganged together which form the three sections of a PI network with high frequency compensation added for wide-band operation. Use the same check-out procedures as the other attenuator models.



MODEL	0/400	0/410
R1	100 VAR LIN	200 VAR LIN
R2, R3	1K VAR dB	1K VAR dB
R4	10	15
R5	8.2	18
R6, R7	75	107
R8, R9	390	390
C1	50	24
C2	3.3	-
C3	4.7	2
C4	*	*2
C5	*.47	*3
L1, L2	-	3T, #28, 1/8 Dia

UNLESS INDICATED OTHERWISE-
ALL RESISTORS ARE IN OHMS, 1/4 WATTS
ALL CAPACITORS ARE IN PICO FARADS
* INDICATES FACTORY SELECTED

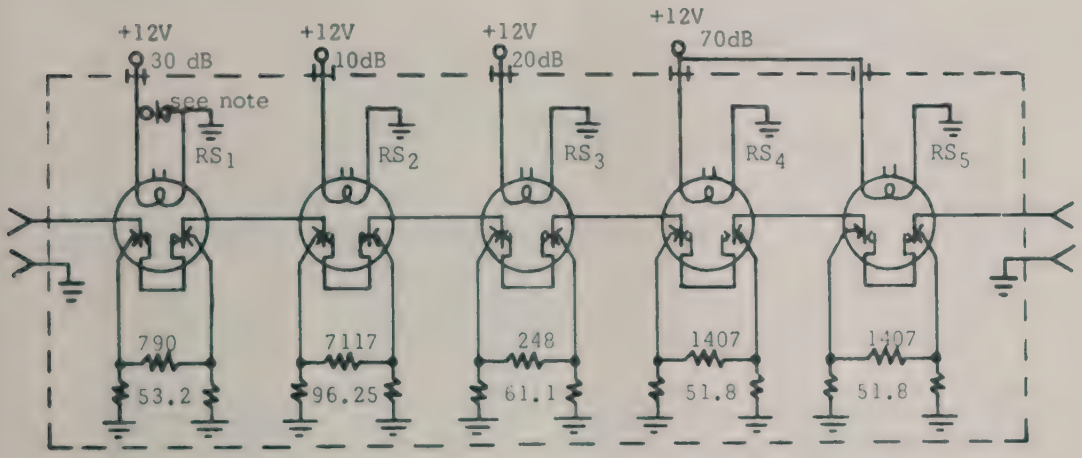
RELAY TYPE, RAPID SWITCHING SPEED
PROGRAMMABLE ATTENUATORS

OTHER ATTENUATION RANGES AND STEPS AVAILABLE ON SPECIAL ORDER

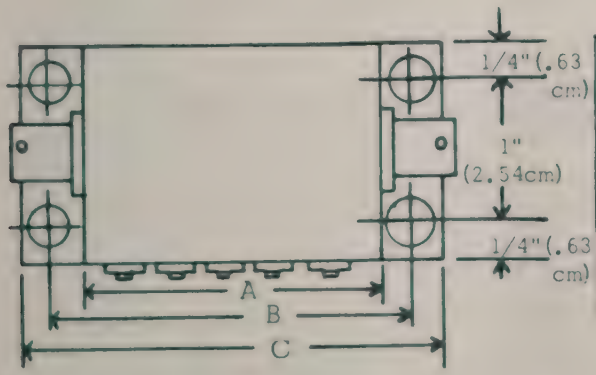
		50 OHM				75 OHM			
MODEL		4440	4450	4460	I/4450	4447	4457	4467	I/4457
FREQ RANGE (MHZ)		DC-1500	DC-1500	DC-1500	DC-1000	DC-1000	DC-1000	DC-1000	DC-750
ATT. RANGE (dB)		0-130	0-127	0-31	0-16.5	0-130	0-127	0-31	0-16.5
STEP (dB)		10, 20, 30, 70	1, 2, 4, 8, 16, 32, 64	1, 2, 4, 8, 16	.1, .2, .4, .8, 1, 2, 4, 8	10, 20, 30, 70	1, 2, 4, 8, 16, 32, 64	1, 2, 4, 8, 16	.1, .2, .4, .8, 1, 2, 4, 8
ACCURACY (± dB or % of dB)	DC-500	±1.0	±1.0	±0.5	.1 -.8dB ±.05 1-8dB ±.2	±1.0	±1.0	±0.5	.1 -.8dB ±.05 1 - 8dB ±.2
	500-1000	±1.5	±1.5	±0.75	.1 -.8dB ±.2 1 - 8dB ±.3	±1.5	±1.5	±0.8	.1 -.8dB ±.2 1 - 8dB ±.3
	1000-1500	±2.5	±3.0	±1.0					
VSWR	DC-500	1.3:1	1.3:1	1.3:1	1.3:1	1.3:1	1.3:1	1.2:1	1.3:1
	500-1000	1.4:1	1.4:1	1.4:1	1.4:1	1.4:1	1.5:1	1.3:1	1.4:1
	1000-1500	1.4:1	1.5:1	1.4:1					
INSERTION LOSS (dB)	DC-500	1.5	2.5	1.5	2.5	1.5	2.0	1.5	2.5
	500-1000	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
	1000-1500	2.0	4.0	2.5					
RF POWER (WATTS)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
SWITCHING SPEED		6 MILLISECONDS PER STEP							
SWITCH LIFE		10,000,000 OPERATIONS PER STEP							
CONTROL VOLTAGE		ATTENUATION INSERTED ±12V, 370 MILLIWATTS PER STEP (OPTIONAL VOLT 5, 6, 9, 18, 26.5) ATTENUATION OUT 0 TO +5 VOLTS							
CONNECTORS		BNC STANDARD. SMA, TNC, N, OPTIONAL							
WEIGHT		12 oz (.34 Kg)							

RELAY TYPE PROGRAMMABLE ATTENUATORS

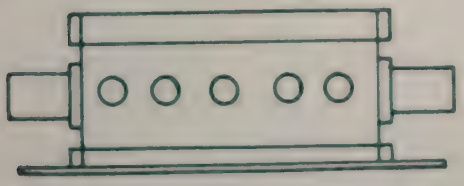
Typical schematic - all model types are similar, with the exception of the attenuation step resistor values. Refer to the chart on page 36 for appropriate values.

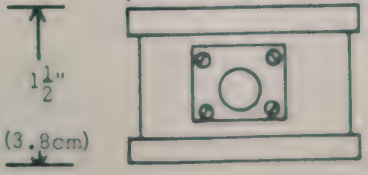


RS_1 through RS_5 - Kay part 0490-0016 (If control voltage is other than 12V, specify value).



MODEL	A	B	C
4440 4460 4447 4467	3" 7.6 cm	3.76" 9.55 cm	4.16" 10.56 cm
4450 4457	4.9" 12.3 cm	5.4" 13.8 cm	5.85" 14.9 cm

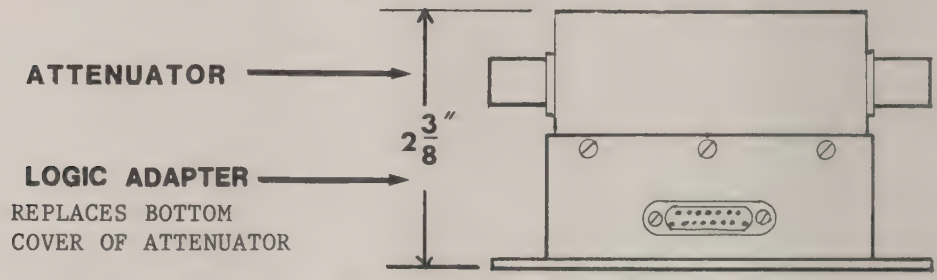




LOGIC ADAPTERS FOR RELAY TYPE PROGRAMMABLE ATTENUATORS

PROVIDES FOR ATTENUATOR CONTROL DIRECTLY FROM TTL CIRCUITS.

BINARY CODING: LOGIC 0 - MINIMUM ATTENUATION
LOGIC 1 - CONTINUOUS DRIVE ATTENUATION INSERTED



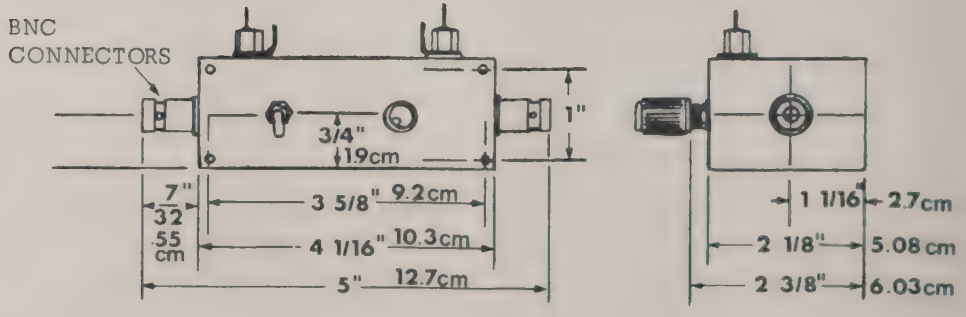
AMPHENOL CONNECTOR FOR LOGIC AND POWER INPUTS

ATTENUATOR MODEL	LOGIC ADAPTER MODEL	POWER
4440 4447 4460 4467	4000 4 or 5 BIT INPUT	12 Volts DC 200 MA
4450 4457 1/4450 1/4457	4001 7 or 8 BIT INPUT	12 Volts DC 320 MA

NOTE: See page 37 for Logic Adapter Schematic.

PROGRAMMABLE ATTENUATORS

MODELS 2000 AND 2100



CONTINUOUSLY VARIABLE PROGRAMMABLE ATTENUATORS

MODEL 2100- 50 Ohms, supply voltage +12V 200MA control voltage 0-12V, DC to 30 KHz (3dB)
MODEL 2000- 75 Ohms, supply voltage +10V 140MA control voltage 0-10V, DC to 30 KHz (3dB)

Frequency Range : 2-500 MHz
Insertion Loss : 6 dB max.
Input Level : 2.0V 10-500 MHz max.
0.5V 2-10 MHz max.

Attenuation Range : 0-76 dB
VSWR : 1.5:1 max.
: 1.2:1 typical
Flatness : (70 dB range):
±1.5 dB 2-500 MHz
±0.5 dB 5-200 MHz

DISTORTION SPECIFICATIONS

Frequency	Input Level	Attenuation Setting	Distortion
2 MHz	0.5V RMS	6-20 dB	36 dB
10 MHz	2.0V RMS	6-20 dB	34 dB

Distortion decreases 6 dB with each input reduction of 6 dB.
Distortion decreases 6 dB with each doubling of the frequency.

TEMPERATURE STABILITY

60 dB setting < 0.1 dB/°C 0-70°C
10 dB setting < .02 dB/°C 0-70°C

CONTROL VOLTAGE VS. ATTENUATION (TYPICAL VALUES)

2000				2100			
dB	Cont. Volts	dB	Cont. Volts	db	Cont. Volts	dB	Cont. Volts.
0	+10	20	1.8	0	+12	20	1.7
1	6.4	30	1.0	1	6.5	30	1.2
2	4.6	40	0.8	2	4.5	40	0.8
3	3.6	50	0.65	3	3.0	50	0.7
6	3.0	60	0.55	6	2.75	60	0.6
10	2.5	70	0.45	10	2.5	70	0.5

CONTROLS AND TERMINALS FOR 2000 AND 2100

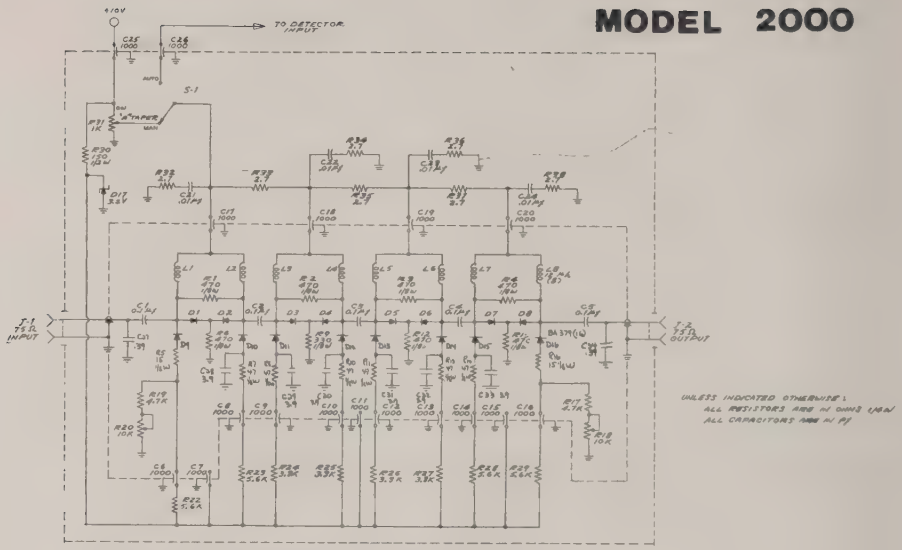
MANUAL/AUTO SWITCH - This switch selects the control mode. In the Manual position, attenuation levels are controlled by the adjacent control. In the Auto position, the level is determined by the external control voltage.
+ TERMINAL - Supply voltage input terminal.
DETECTOR INPUT - Control voltage input terminal.
R.F. CONNECTORS - RF signal input and output connectors.

The 2000 and 2100 attenuator models may be used as AM modulators and R.F switches.

The continuously variable programmable attenuator models consist of four PI - Network in series. The shunt and series elements use pin diodes as resistors, the value of which are determined by the current passing through them. Mal-functioning of these models is usually caused by a faulty diode or by a failure of a component in the current supplying circuitry of one or more of the sections, and can usually be located with a voltmeter using normal trouble-shooting procedures. In cases of high minimum attenuation, connect the unit to an R.F. signal source and set the control voltage for maximum R.F. output. By-pass each series diode section in succession to find the one that is presenting the high attenuation.

It is very important to replace the R.F. gasket under the R.F. box cover to obtain the correct high frequency attenuation characteristics.

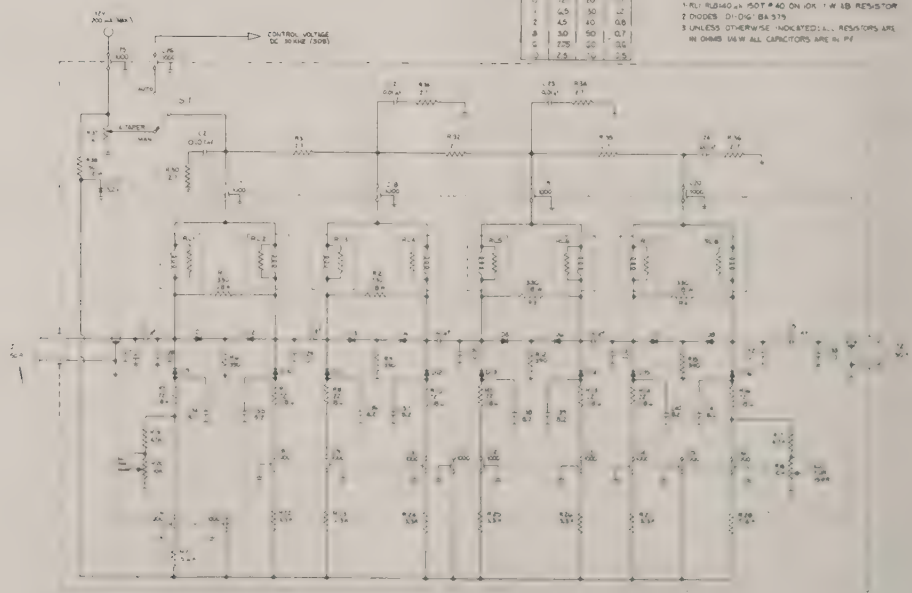
MODEL 2000



UNLESS INDICATED OTHERWISE:
ALL RESISTORS ARE IN OHMS 1/4W
ALL CAPACITORS ARE IN PF

NOTE:
IMPEDANCE - 75 ohms BNC CONNECTORS
FLATNESS (OVER 0 TO 70 DB ATTENUATION RANGE) 1 - 500 MHz ± 1.5 DB
2 - 340 MHz ± 0.5 DB
ATTENUATION RANGE - 0 DB TO 78 DB (EXCLUDING INSERTION LOSS)
INSERTION LOSS. 6DB MAX.
INPUT SIGNAL (MAX LEVEL): 2V RMS 10-500 MHz, 0.5V RMS 3-10 MHz
V.S.W.R. 1.5:1 MAX.
CONTROL VOLTAGE: 0 V TO +10 V (MAX)

MODEL 2100



DB VS CONTROL VOLTAGE

DB	+V	DB	+V
0	.2	70	7
1	0.5	30	2.2
2	4.5	40	0.8
3	3.0	50	0.7
6	2.25	60	0.5
9	2.5	70	0.5

NOTES
1. RLY RL9140-12 OR 150T-40 ON 10K 1/4W 1% RESISTOR
2. DIODES D1-D10: BA 379
3. UNLESS OTHERWISE INDICATED: ALL RESISTORS ARE IN OHMS 1/4 W ALL CAPACITORS ARE IN PF

SPECIFICATIONS

1. IMPEDANCE 50 OHMS
2. VSWR 1.5:1 MAX
3. ATTENUATION RANGE 0 DB TO 78 DB EXCLUSIVE OF INSERTION LOSS)
4. INSERTION LOSS 6 DB MAXIMUM
5. FLATNESS (OVER 70 DB ATTENUATION) ± 1.5 DB 1 500 MHZ
   ± 0.5 DB 1 250 MHZ
6. INPUT LEVEL (MAX): 2.0 V RMS @ 500 MHZ; 0.5 V RMS @ 10 MHZ
7. CONTROL VOLTS: 0-12 V

SECTION III

INCOMING ELECTRICAL INSPECTION AND PERIODIC CALIBRATION GUIDE

The important specifications which should be inspected are impedance match, insertion loss and attenuation accuracy. The inspection procedure may best be carried out in two phases, DC and low frequency (250 MHz) and high frequency (above 250 MHz).

DC - 250 MHz CHECK - measurements taken at DC will usually show very little variations up to 250 MHz and thus the results of these DC measurements can be considered to also indicate the accuracy to be expected up to 250 MHz. The equipment required for these checks is usually available in any well equipped test facility.

IMPEDANCE MATCH MEASUREMENT EQUIPMENT:

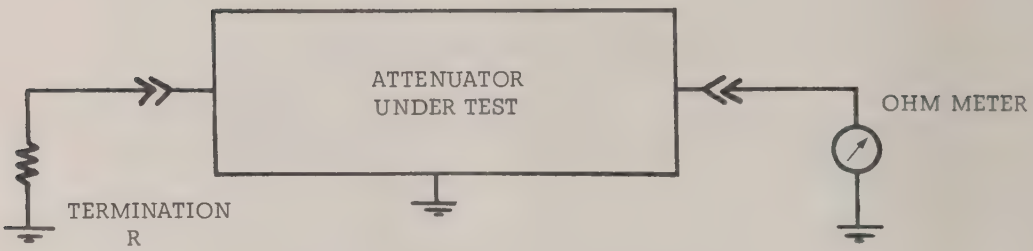
- Open end connectors capable of mating with the attenuator connectors.
- Multimeter (Digital Type Preferred)
- Terminating resistor having the same ohmic value as the characteristic impedance of the attenuator under test.

PROCEDURES:

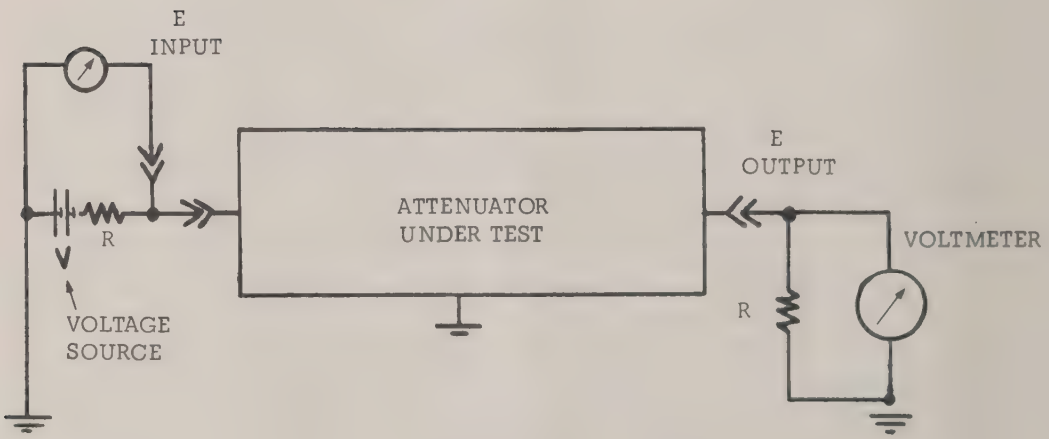
a. Connect the mating connectors to the attenuator.
b. Connect the terminating resistor across one of the open end connectors.
c. Connect the multimeter set for resistance measurements across the other connector.
d. Measure and note the resistance reading of each step as it is individually switched in.
e. Measure and note the resistance of each step in the opposite direction by reversing the connectors on the attenuator.
f. Calculate the VSWR using the measured resistance and the specified characteristic impedance of the attenuator, dividing the larger of the two numbers by the smaller.

Example - measured value - 51 ohms
specified impedance - 50 ohms
$51 \div 50 = 1.02$
VSWR is 1.02:1

DC/LOW FREQUENCY VSWR CHECK



DC/LOW FREQUENCY ACCURACY AND INSERTION LOSS CHECKS



FORMULA FOR CALCULATING INSERTION LOSS

$$dB = 20 \log \frac{E\ INPUT}{E\ OUTPUT}$$

R = NOMINAL IMPEDANCE OF ATTENUATOR UNDER TEST

DC/LOW FREQUENCY ATTENUATION ACCURACY AND INSERTION LOSS CHECKS

EQUIPMENT:

- DC voltmeter (suggest digital)
- Voltage source (2 volts 0-20 dB, 10V 30 dB and higher)
- Terminating resistors of value equal to the specified characteristic impedance of the attenuator under test within ±1%
- Open end connectors capable of mating with attenuator connectors

PROCEDURE:

a. Connect the equipment as shown in the diagram. For measuring steps of 20 dB or less, use a 2 volt power source which will provide 1 volt input at the attenuator; for steps above 20 dB, use a 10 volt source to provide 5 volts at the input. Care should be taken not to exceed the power limitations of the attenuator (see chart).

Max. Attenuator Input Voltage (Continuous)

Impedance	1 Watt	.5 Watt
50	7.07	5.0
75	8.7	6.1
90	9.5	6.7

b. With all attenuation removed (0 dB) measure input and output voltages. Calculate the insertion loss.

$$\text{Attenuation (dB)} = 20 \times \text{LOG} \frac{\text{E Input}}{\text{E Output}}$$

c. Insert the attenuation step to be checked

d. Measure input and output voltages and calculate the attenuation.

Note: If a well regulated power source is used, the input voltage will remain constant for all attenuation measurements.

HIGH FREQUENCY INSPECTION

The same specifications that were tested in the DC-low frequency check, VSWR, insertion loss and attenuation accuracy, will be measured in the high frequency inspection. Somewhat more specialized equipment is required and precautions must be taken to avoid the possibility of obtaining misleading data that may tend to indicate that the attenuator does not meet its specifications.

All measuring equipment, interconnecting cabling and connector adapters must have the same characteristic impedance as the attenuator under test, and must possess good VSWR characteristics at all frequencies to be tested.

The signal sources must be stable, and not affected by changes in circuit loading. It is desirable to use attenuator pads (6 or 10 dB) for isolation between the oscillator and the attenuator to stabilize the measuring system. All system R.F. leakage must be kept to an absolute minimum, particularly at the higher test frequencies and higher attenuation values.

HIGH FREQUENCY VSWR

The most convenient method to measure VSWR is with a return-loss bridge in conjunction with a wide-band sweeping R.F. generator and an oscilloscope; see page 22 for Block Diagram. With this set-up, the VSWR can be measured over the entire frequency range at one time.

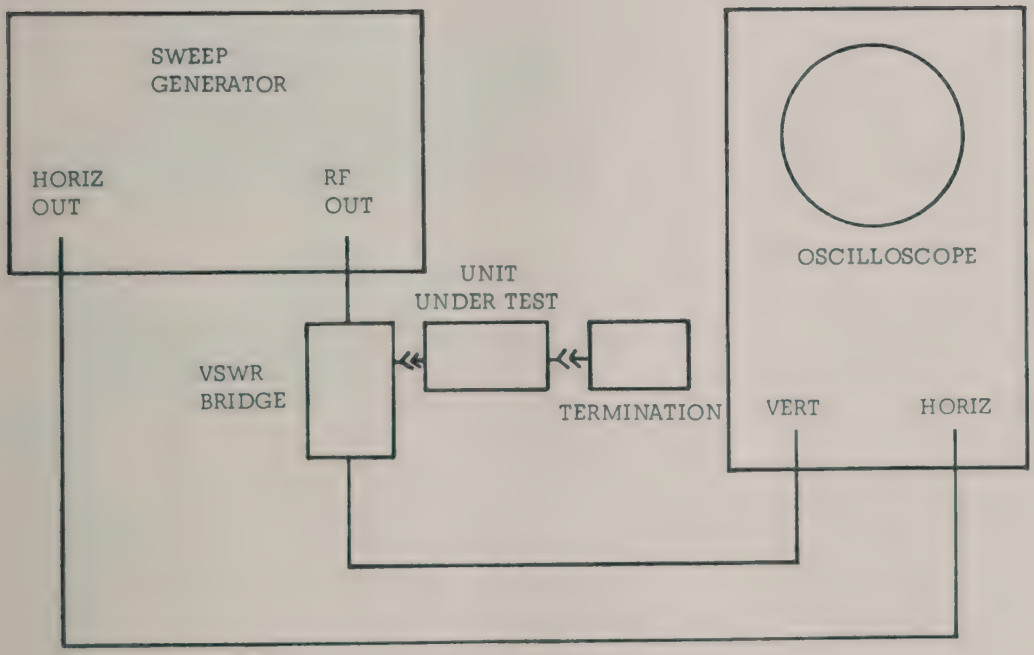
The most convenient method to measure VSWR is with a return-loss bridge in conjunction with a wide-band sweeping R.F. generator and an oscilloscope. With this set-up, the VSWR can be measured over the entire frequency range at one time.

The attenuator must be connected directly to the return-loss bridge without the use of inter-connecting cables. If it is necessary to use connector adapters, they must have very good match characteristics or they will produce inaccurate VSWR measurements.

A high quality termination of the correct impedance value which is known to have good VSWR characteristics over the frequency range to be checked must be connected directly to the opposite end of the attenuator without the use of cables. Connector adapters, if required, must also have very good wide frequency VSWR characteristics. Interconnecting hardware frequently has poor VSWR qualities at high frequencies causing measurements which may erroneously indicate that the attenuator exceeds the VSWR specifications. Check the VSWR in the 0 dB mode and with each step individually inserted. Reverse the input-output connections and repeat the procedure.

BLOCK DIAGRAM

WIDE-BAND VSWR MEASUREMENTS



VSWR measurements may also be made using slotted line and standard delay line techniques, or directly with network analyzers with the same precautions.

WIDE BAND HIGH FREQUENCY ATTENUATION ACCURACY AND INSERTION LOSS

Attenuation measurements may be made directly by using sophisticated test equipment, such as network analyzers. However, many times this equipment is not available, so that a brief discussion of other methods will be given.

In all cases, it is imperative that circuit components have the correct impedance. (Cables, terminations, etc.).Interconnecting cable lead lengths should be as short as possible. In some cases it may be necessary to use attenuator pads for buffering between the attenuator under test and other equipment to maintain system stability. These techniques require the use of a stable wide-band signal source of the correct impedance.

MEASURED TECHNIQUES

Attenuation measurements require connecting the attenuator under test into a matched impedance system with a signal source, termination and equipment for measuring input and output power or voltage. After recording the input and output measurements, the attenuation may be calculated with the following formulas.

$$\text{Attenuation (dB)} = 10 \text{ LOG } \frac{\text{Power Input}}{\text{Power Output}}$$

$$\text{Attenuation (dB)} = 20 \text{ LOG } \frac{\text{Voltage Input}}{\text{Voltage Output}}$$

COMPARISON TECHNIQUE

A substitution method requiring an accurately calibrated attenuation standard can be used for making wide band comparison measurements. The systems should be connected as shown on page 24. A wide band R.F. amplifier may be required when checking steps of 30 dB or more.

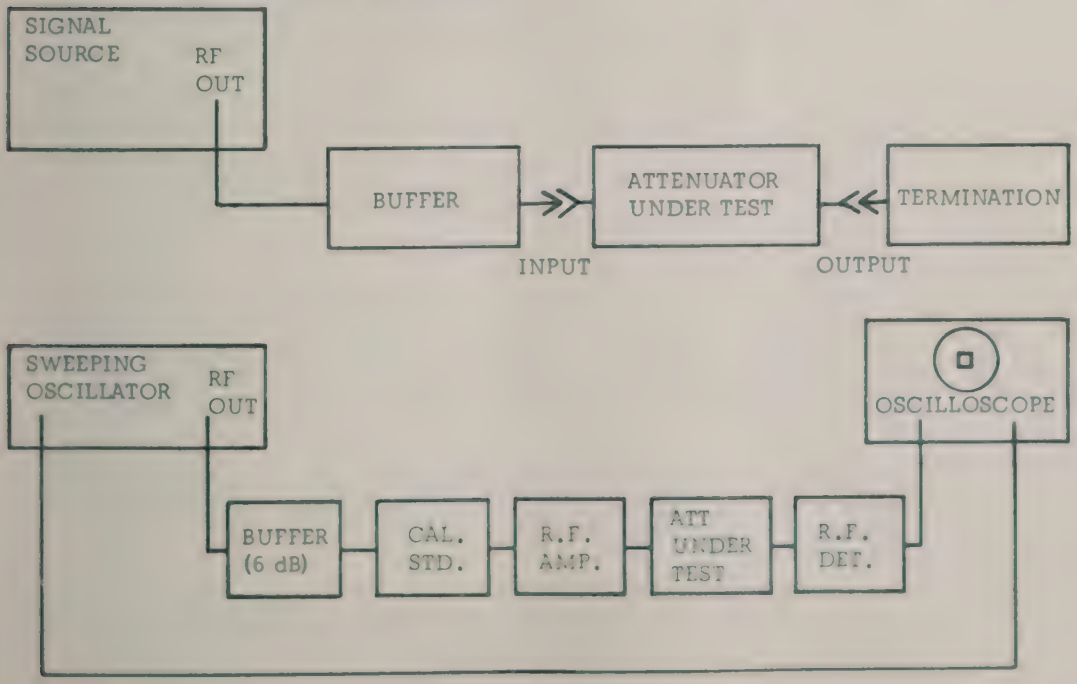
Insert the attenuation value to be checked with the calibration standard and then mark the oscilloscope screen with a grease pencil. Also calibrate and mark points 1 dB above and below this level. Switch out the calibration step and switch in the equivalent step on the unit under test.

Compare the scope display against the calibration points on the oscilloscope screen. When using an R.F. amplifier, make certain that it is not overloaded by excessively high input signals.

Another comparison method which provides very accurate results utilizes a heterodyne system with the calibration standard located in the I.F. section of a receiver system. The attenuator under test is checked at a specified CW frequency which is then heterodyned with a local oscillator. The resulting I.F. signal is then amplified, connected to the calibration standard attenuator, detected, and used to drive a calibrated meter. The attenuation value of the step under test is compared with the calibration standard and the error is indicated on the output meter. This method, although providing very accurate measurements, is inconvenient to use for obtaining wide-band calibrations. When the calibration frequency is varied it is necessary to correct the local oscillator frequency, so that the resultant heterodyne (sum or difference frequency) corresponds with the design frequency of the I.F. amplifier.

ATTENUATION ACCURACY MEASUREMENTS

WHEN TAKING MEASUREMENTS, USE EQUIPMENT THAT WILL NOT CAUSE CIRCUIT LOADING OR MISMATCH.



SECTION IV

OPERATION

Attenuators are transmission line components designed primarily for power level reduction. They also find use as buffering networks between circuits of different impedances, and when they are connected between unstable system components they serve as isolation to reduce interaction.

Before an attenuator is connected into any circuit, it must be determined that its maximum power rating will not be exceeded. Transmission lines that serve multi-functions very often have high AC or DC voltages present along with the low level signal voltages, and these must be isolated before the attenuator is connected. Capacative coupling will very often serve this purpose. Overloading an attenuator can cause complete failure or result in inaccurate operation. (Refer to voltage chart on page 20).

When an attenuator is connected into the circuit, some insertion loss will be introduced even when it is set to the 0 dB position. This loss, although usually low, may be as high as 0.5 dB at operating frequencies approaching 1 GHz on some models. As the attenuation steps are switched in the attenuation loss is equal to the sum total of the attenuation step value plus the insertion loss. Thus, when fractional or low value attenuation steps are to be used at high frequencies, it is advisable to check the attenuator insertion loss specification.

Other factors that can affect the accuracy are impedance match and signal leakage. For maximum accuracy, it is essential that the attenuator impedance be the same as that of the other system components, and that interconnecting cabling and connections have good VSWR characteristics. The relationship between VSWR and circuit losses are shown on the chart on page 28.

It is also important, particularly at high frequency operation and/or high attenuation levels, that all system components have very low radiation and that minimum lead lengths be used. Any signal that leaks around an attenuator will contribute to inaccuracies and may become significant enough to make the attenuator completely ineffective.

Attenuators are symmetrical, (bi-directional) thus either connector may serve as the input or output connection. Both connectors have identical impedance characteristics.

With inline models, the attenuation steps are inserted when the switch is thrown to the "In" position. The total attenuation is the sum of the

values that are inserted.

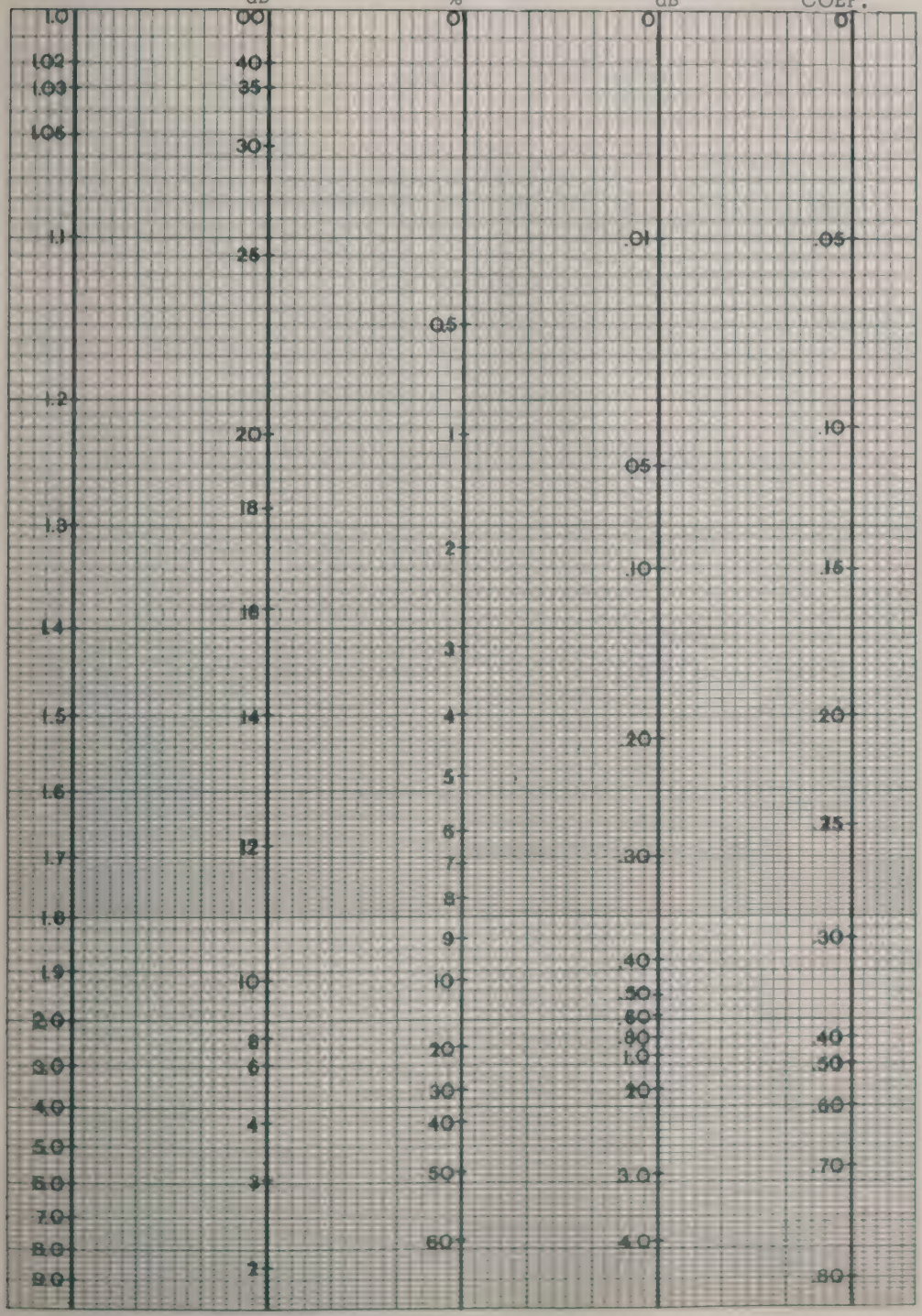
With rotary type models the inserted attenuation is indicated on the knob, usually increasing in value as the knob is rotated in the clockwise direction.

In some instances, it may be required to use an attenuator in a circuit that will exceed its wattage specification. This can be accomplished by inserting a fixed high power attenuator pad ahead of the step attenuator input to reduce the power to an acceptable level. This will, however, limit the minimum insertion loss. Refer to the dB/voltage, power conversion table to determine the attenuation value (page 27).

Attenuators may be used beyond their rated maximum power if the duty cycle is reduced. Frequently, attenuators are used in systems that deliver high power, narrow width, or widely separated pulses. In these cases, the allowable peak power is limited by the required duty cycle. The input voltage, however, may not exceed 300V peak.

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

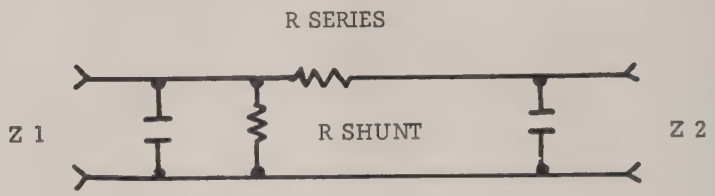
Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	dB+	Voltage Ratio	Power Ratio
1.000	1.000	0	1.000	1.000	.447	.200	7.0	2.239	5.012	.200	.0398	14.0	5.012	25 12
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28 18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28 84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	.794	1.0	1.122	1.259	.398	.159	8.0	2.512	6.310	.178	.0316	15.0	5.623	31.62
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33 11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35 48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37 15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	.631	2.0	1.259	1.585	.355	.126	9.0	2.818	7.943	.159	.0251	16.0	6.310	39 81
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46 77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6 918	47 86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	.501	3.0	1.413	1.995	.316	.100	10.0	3.162	10.000	.141	.0200	17.0	7.079	50 12
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51 29
692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53 70
676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57 54
653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58 88
646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7 762	60 26
638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
631	.398	4.0	1.585	2.512	.282	.0794	11.0	3.548	12.59	.126	.0159	18.0	7 943	63 10
624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8 035	64 57
617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8 222	67 61
603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69 18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70 79
589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18 7	8 610	74 13
575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75 86
569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.935	15.49	.114	.0129	18.9	8.811	77 62
.562	.316	5.0	1.778	3.162	.251	.0631	12.0	3.981	15.85	.112	.0126	19.0	8 913	79 43
556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19 1	9 016	81 28
550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	110	.0120	19.2	9 120	83 18
543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16 98	.108	.0118	19 3	9 226	85 11
537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9 333	87 10
531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	106	.0112	19 5	9 441	89 13
525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19 6	9 550	91 20
519	.269	5.7	1 928	3.715	.232	.0537	12.7	4.315	18.62	104	.0107	19 7	9 661	93 33
513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	102	.0105	19 8	9 772	95 50
507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9 886	97 72
501	.251	6.0	1.995	3.981	.224	.0501	13.0	4.467	19.95	.100	.0100	20.0	10.000	100 00
496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20 42		10^{-3}	30		10^{3}
490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89					
484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^{2}	10^{4}
479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21 88					
											10^{-5}	50		10^{5}
.473	.224	6.5	2.113	4 467	.211	.0447	13.5	4.732	22 39	10^{-3}	10^{-6}	60	10^{3}	10^{6}
468	.219	6.6	2.138	4.571	.209	.0437	13.6	4 786	22.91		10^{-7}	70		10^{7}
462	.214	6.7	2 163	4.677	.207	.0427	13.7	4 842	23.44	10^{-4}	10^{-8}	80	10^{4}	10^{8}
457	.209	6.8	2.188	4.786	.204	.0417	13.8	4 898	23 99		10^{-9}	90		10^{9}
452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55					
										10^{-5}	10^{-10}	100	10^{5}	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^{6}	10^{12}



VSWR NOMOGRAPH

It is sometimes desirable to change the characteristic impedance of a circuit. This can be done with a resistive pad with the sacrifice of some power. For high frequency operation, the component lead lengths should be short and the VSWR should be checked. Optimum VSWR can be obtained by selecting values for the shunt capacitors which provide the best impedance match.

Suggested Network Values



Z1 (OHMS)	Z2(OHMS)	R SHUNT (OHMS)	R SERIES (OHMS)	LOSS dB
50	75	89	43	5.5
50	90	201	23	7.2
75	90	184	37	4.3

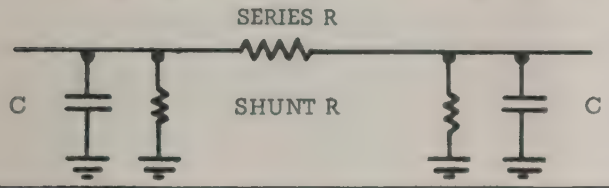
SECTION V

MAINTENANCE AND REPAIR

Design Features

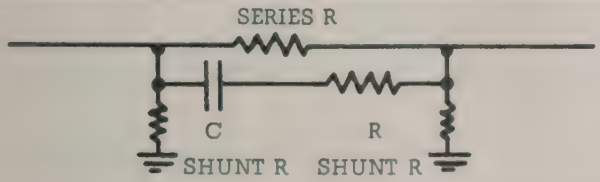
Wide-band accuracy and low loss characteristics are assured by the use of quality components, state-of-the-art design, and careful, individual calibration. Most models are designed using unbalanced symmetrical PI networks with frequency compensation circuits and impedance matching components.

Some typical examples are illustrated in the following diagrams. In some cases the values of the components are selected during the calibration procedure, and thus may vary with individual units.



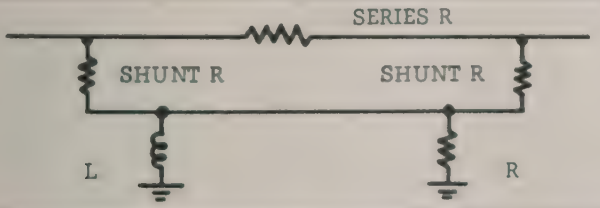
Shunt capacitors added to reduce VSWR

Inline models-various steps
Rotary models-various steps



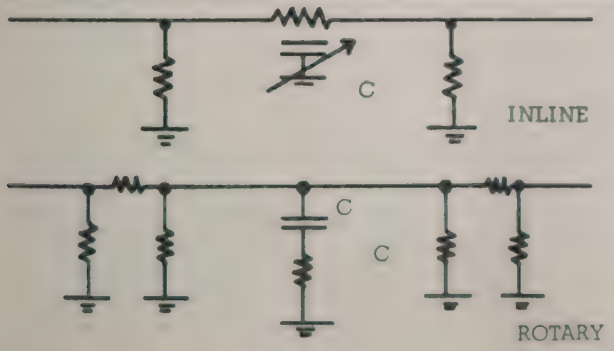
Series compensation added to decrease mid and high frequency attenuation

Inline models 1 thru 10 dB



Shunt inductance added to decrease high frequency attenuation

Inline models 1 thru 10 dB



Shunt capacity added to increase high frequency attenuation

Inline- 20, 30 dB

Rotary- 10-70 dB

Inline and Rotary Models

These attenuator models are passive devices and consequently require very little maintenance. An annual calibration check should be performed following the procedures outlined in the calibration guide section of this manual.

The factors that affect their long-term accuracy other than misuse or physical damage is the wearing out of switches and connectors, and the slow changes of component valves due to aging.

The switch contact surfaces utilize precious metal alloys to assure low resistance connections. A prolonged period of nonuse, however, may allow an oxide to buildup , resulting in erratic switch operation when the units are first put into service. This problem will correct itself after a short period of use.

Inline and Rotary Model Trouble Shooting Guide

- No output, 0 dB position - use ohmeter to check for short or open connectors, switches or interconnecting straps.
- No output, attenuation step - use ohmeter to check for open series, resistor, open switch, faulty rotary switch contact.
- Intermittent output - faulty switch, faulty connector.
- Incorrect DC attenuation - damaged resistor due to overload, perform DC VSWR check to locate incorrect shunt or series resistor. Incorrect reading at one connector only usually indicates a faulty shunt resistor. Incorrect readings at both connectors can be caused by faulty shunt or series resistors.
- Incorrect DC VSWR - see incorrect DC attenuation.

High Frequency Attenuation Tuning

On the toggle switch models- the 20 and 30 dB steps have gliders or copper straps that are used to tune for the correct high frequency attenuation. These are accessible when the bottom cover is removed. (Miniature models have shield plates with access holes). Adjusting the gliders or straps so that they approach the center of the series resistor body increases the shunt capacity and thus increases the high frequency attenuation. This adjustment has very little affect on the VSWR.

The 1 thru 10 dB steps have inductance coils or extended lead lengths on the shunt resistors. Adjusting the coil turns or the wire lengths tunes the high frequency attenuation of these steps. The above final adjustments on some model inlines will be affected somewhat when the cover of the inlines is reinstalled. Hold the cover in place and check the high frequency attenuation before permanently installing the cover.

The rotary and co-axial models do not have tuning adjustments , and the high frequency attenuation cannot be readily adjusted.

Inline Disassembly Instructions

Toggle switch inline models:

1. Remove felt from bottom
2. Remove screws holding bottom plate.
3. Some miniature models have a shield plate and R.F. gasket under the bottom cover. To remove these, simply remove the holding screws.

To reassemble, reverse the above procedures. Care must be exercised with the models that have adjustment gliders that they be disturbed as little as possible when the R.F. gasket and shield plate are tightened down. To assure good shielding characteristics, be sure that all of the screws are properly tightened.

Replacing Components

Individual resistors, completely wired switches and complete co-axial segments are available for in-field replacement. Consult the tables for values and part numbers. Care should be taken when replacing resistors that they are wired as closely as possible to the positions of the original parts to minimize the high frequency retuning requirements. To replace toggle switches, remove the panel nut and unsolder the interconnecting straps. The standard size switches can then be lifted out without the need to unsolder the individual components. With miniature switches, it is neccessary to unsolder the component ground connections before attempting to remove the switch. Put the replacement wired switches into the housing. With standard switches make certain that the ground clip is firmly seated over the case rib. The component ground leads of the miniature switches should be soldered to the same places as the originals. Resolder the interconnecting straps and firmly tighten the panel nut.

Rotary Attenuator Disassembly

1. Remove the four screws that secure each of the connectors.
2. Remove the connectors and their mounting blocks.
3. Remove the three screws that hold the front plate to the housing.
4. Pull the front plate away from the housing and remove the R.F. gasket from the channel. Remove the grounding washer from shaft on rear of rotor.
5. Locate the defective step and replace the faulty components.
6. Replace grounding washer on shaft behind rotor. Put gasket back into channel and insert rotor housing.
7. Rotate the rotor in the housing until the mounting screw holes line up and the contacts, as viewed through the connector holes, face straight up so that they will be centered under the connector fingers when the connectors are installed.
8. Reinsert the front plate mounting screws.
9. Install the connectors, making certain that the contact fingers go around each side of the contact board.

REPLACEMENT R.F. CONNECTORS

MODEL	TYPE	IMPEDANCE (OHMS)	KAY PART NUMBER
STD. INLINE	BNC	50	1250-0003
	TNC	50	7117-9900
	SMA	50	1250-0138
	N	50	1250-0001
	BNC	75	7134-2300
	F	75	7129-6004
MINI INLINE	BNC	50	7111-4801
	TNC	50	7117-9900
	SMA	50	1250-0138
	BNC	75	7134-2300
	F	75	7129-6004
CO-AX INLINE	N-MALE	50	7113-4001
	N-FEMALE	50	7113-4002
ROTARY	BNC	50	7082-3301
	SMA	50	7144-1100
	BNC	75	7136-2300
	TNC	50	7091-7700
	TNC	75	7136-2400

PART NUMBERS FOR ORDERING COMPLETELY WIRED INLINE SWITCH ASSEMBLIES.

	STEP DB	STANDARD MODELS 50 OHM	75 OHM	90 OHM	MINIATURE MODELS 50 OHM	75 OHM	90 OHM
	Unwired Switch	7144-2200	7144-2200	7144-2200	7144-2100	7144-2100	7144-2100
WIRED SWITCHES	.1	7144-2201	7144-2219	7144-2237	7144-2101	7144-2119	7144-2137
	.2	-2202	-2220	-2238	-2102	-2120	-2138
	.3	-2203	-2221	-2239	-2103	-2121	-2139
	.4	-2204	-2222	-2240	-2104	-2122	-2140
	.5	-2205	-2223	-2241	-2105	-2123	-2141
	.6	-2206	-2224	-2242	-2106	-2124	-2142
	.7	-2207	-2225	-2243	-2107	-2125	-2143
	.8	-2208	-2226	-2244	-2108	-2126	-2144
	.9	-2209	-2227	-2245	-2109	-2127	-2145
	1	-2210	-2228	-2246	-2110	-2128	-2146
	2	-2211	-2229	-2247	-2111	-2129	-2147
	3	-2212	-2230	-2248	-2112	-2130	-2148
	4	-2213	-2231	-2249	-2113	-2131	-2149
	5	-2214	-2232	-2250	-2114	-2132	-2150
	6	-2215	-2233	-2251	-2115	-2133	-2151
	10	-2216	-2234	-2252	-2116	-2134	-2152
	20	-2217	-2235	-2253	-2117	-2135	-2153
	30	-2218	-2236	-2254	-2118	-2136	-2154

UNWIRED KAY TEFLON BODIED RF SWITCHES MAY BE ORDERED BY USING THE FOLLOWING MODEL NUMBERS.

DPDT
NON-SHORTING

GENERAL PURPOSE
Standard Size- 254TX
Miniature-254TMX

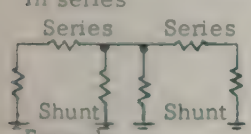
DPDT WITH SHORTING STRAP

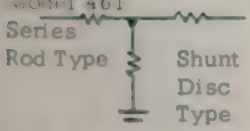
ATTENUATOR TYPE
Standard Size-254T
Miniature-254TM

CO-AXIAL INLINE ATTENUATOR BLOCK ASSEMBLIES FOR MODEL 461 ATTENUATORS.

STEP DB	PART NUMBER	STEP DB	PART NUMBER
1	7101-7101	10	7101-7110
2	7101-7102	20	7101-7120
3	7101-7103	30	7101-7130
6	7101-7106		

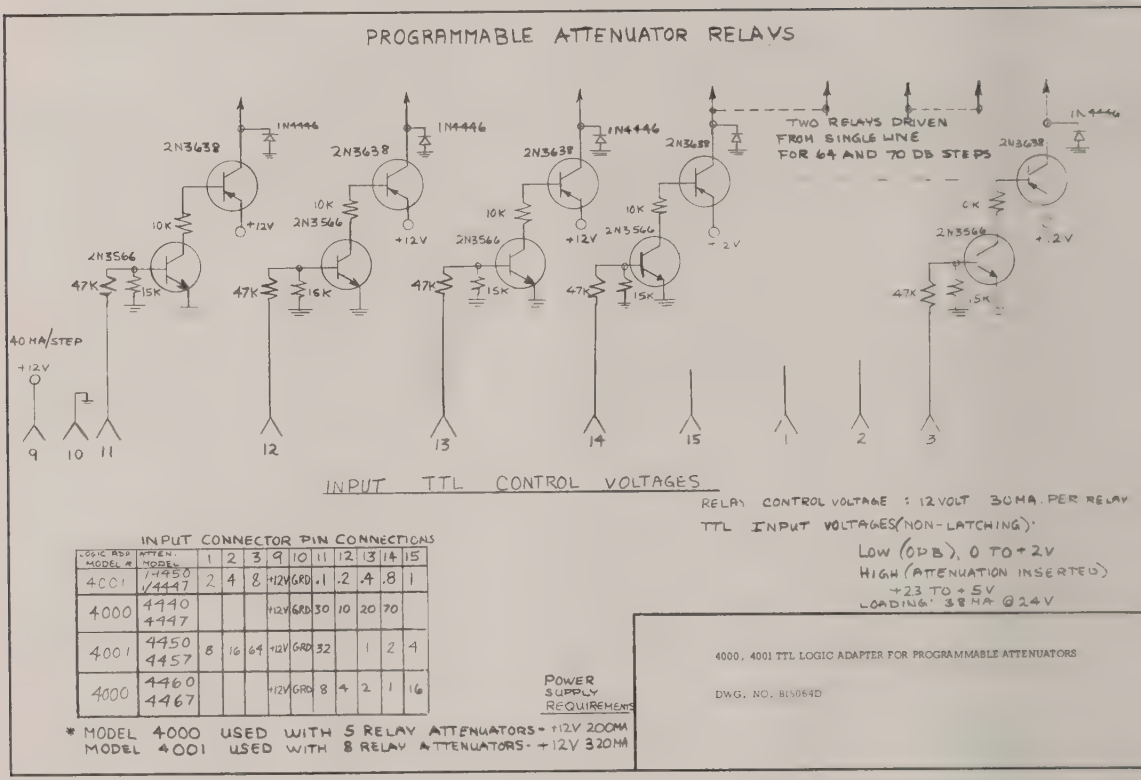
REPLACEMENT PRECISION RESISTOR INFORMATION 1%, NON INDUCTIVE
LOW CAPACITY TYPES

SCHEMATIC	STEP DB	50 OHM SERIES	50 OHM SHUNT	75 OHM SERIES	75 OHM SHUNT	90 OHM SERIES	90 OHM SHUNT
INLINE Some Models Only	.1		21173K				
	.2		1.086K				
	.3		725				
INLINE Single Step Complete wired assemblies may be ordered.	.1	-	4340	-	12950	1.0377	15570
	.2	1.151	4340	1.727	6510	2.0718	7812
	.3	1.727	2895	2.590	4343	3.1084	5211
	.4	2.305	2173	3.458	3260	4.4149	3911
	.5	2.87	1745	4.305	2620	5.184	3190
	.6	3.455	1449	5.183	2172	6.219	2607
	.7	4.035	1242	6.053	1863	7.263	2236
	.8	4.605	1086	6.908	1629	8.289	1956
	.9	5.185	967	7.778	1450	9.333	1740
ROTARY May have two steps in series  Example 50 dB Step 20 dB + 30 dB	1	5.81	863	8.72	1305	10.38	1565
	2	11.62	436	17.4	654	20.9	785
	3	17.6	292	26.45	438	31.7	526
	4	23.8	221	35.7	332	42.9	398
	5	30.4	178	45.7	268	54.7	321
	6	37.4	150	56.1	226	67.2	271
	7	44.8	131	67.2	196.5	80.7	235
	8	52.8	116	79.2	174	95.1	209
	9	61.5	105	92.3	158	110.9	189
	10	71.17	96.15	106.76	144	128	173
	20	248	61.1	372	91.8	446	110
	30	790	53.2	1185	79.9	1422	95.9
	35	1407	51.8	2111	77.7	2530	93.3
Inlines Rated for 1W	20	248	122.2				
	30	790	106.5				

CO-AXIAL Model 461 Series Rod Type Shunt Disc Type  It is recommended that complete assemblies be ordered. See Inline parts list (page 38).	STEP	SERIES	PART NUMBER	SHUNT	PART NUMBER
	1	2.875	12064-1	431.3	12064-2
	2	5.731	12064-3	216.2	12064-4
	3	8.55	12064-15	141.9	12064-16
	6	16.61	12064-17	69.93	12064-18
	10	25.97	12064-9	35.14	12064-10
	20	40.91	12064-11	10.10	12064-12
	30	46.9	12064-13	3.189	12064-14

WHEN ORDERING RESISTORS, PLEASE GIVE ATTENUATOR MODEL NUMBER, RESISTOR VALUE, AND ATTENUATION STEP.

LOGIC ADAPTER SCHEMATIC



INPUT CONNECTOR PIN CONNECTIONS

LOGIC ADP MODEL #	ATTEN. MODEL	1	2	3	9	10	11	12	13	14	15
4001	1-4450 /4447	2	4	8	+12V	GRD	.1	.2	.4	.8	1
4000	4440 4447				+12V	GRD	30	10	20	70	
4001	4450 4457	8	16	64	+12V	GRD	32		1	2	4
4000	4460 4467				+12V	GRD	8	4	2	1	16

* MODEL 4000 USED WITH 5 RELAY ATTENUATORS - +12V 200MA
MODEL 4001 USED WITH 8 RELAY ATTENUATORS - +12V 320MA

POWER SUPPLY REQUIREMENTS

4000, 4001 TTL LOGIC ADAPTER FOR PROGRAMMABLE ATTENUATORS

DWG. NO. B150640

SECTION VI

FACTORY SERVICE AND SPARE PARTS

In Warranty Repairs -

All Kay attenuators are warranted for 1 year. Units returned for repair within this period will receive prompt attention and usually are ready for reshipment within one week from the received date. Failures due to overload or abuse are not covered by the warranty.

Out of Warranty Repairs -

Unless otherwise instructed, each unit returned for repair will be estimated for repair charges, and the customer notified of the charges. Repairs will be completed as soon as possible after an ok to proceed is received. An estimating charge will be made for attenuators that are not repaired. All equipment returned should be accompanied by a notice stating the problem and the name, address and phone number of the person qualified to ok the repair estimate, and/or to supply further detailed information if it is required. All repair work carries a one year warranty.

Calibration -

All calibration is carried out with references and instruments whose accuracy is referenced to the NBS. Certificates of compliance are available. Calibration data is available. A charge is made for each frequency at which the data is requested.

Repair Parts -

Repair and replacement parts are available from the factory Spare Parts Department. All requests for parts should include the attenuator model and serial number, the dB value of the step in which the part is located, where applicable, and the part value or number. For replacement switches (wired or unwired) or precision resistors, see charts in the maintenance section of this manual.

PARTS ORDER SHEET

COMPANY _____

ADDRESS _____

_____

INSTRUMENT CATALOG NO. _____

INSTRUMENT SERIAL NO. _____

SCHEMATIC REFERENCE NO. _____

KAY PART NO. _____ IMPEDANCE _____

DB STEP _____

PART DESCRIPTION:

REMARKS

NOTES

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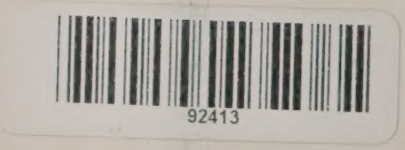
NOTES

NOTES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